

## Stakeholder Charrette Recommendations

### Charrette #3 Community Outreach

March 17, 2021

## Char•rette

/SHə'ret/

*noun*

A meeting in which all stakeholders in a project attempt to **resolve conflicts** and **map solutions**.

In Massachusetts, two networked geothermal demonstrations using ground source heat pumps will be installed this year. Networked geothermal is a promising method for providing renewable heating and cooling to buildings to meet our state's greenhouse gas emissions mandate.

In an effort to support and improve the installations, HEET is organizing monthly "charrettes" throughout 2021, where participating stakeholders share knowledge to identify issues and find solutions.

The purpose of this two-hour charrette, on March 17th, was to begin to develop outreach to potential building owners, tenants, and occupants participating in the initial GeoMicroDistrict installations.

The 79 stakeholders in the charrette included utility executives, regulators, labor representatives, community organizations, advocates, legislators, geothermal designers and installers, and heat pump installers, and manufacturers.

HEET deeply thanks all the stakeholders for their work, which is shared with gas utilities, state regulators, and other stakeholders.<sup>1</sup>

This report is a summary of stakeholder recommendations.

## Executive Summary: Stakeholder Recommendations

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*See Appendix A for the detailed recommendations by the stakeholders. The executive summary below captures high level insights and examples and is not exhaustive or comprehensive.*

For the purposes of this executive summary, “stakeholders” refers to those attending the Charrette, and “participant” refers to those directly affected by the GeoMicroDistrict installation such as building owners, tenants, and occupants, or business customers.

The Charrette started with short presentations on the following topics:

- Introduction and benefits of GeoMicroDistricts—Audrey Schulman and Zeyneb Magavi
- Market transformation and motivational techniques—Sarah Griffith, HEET
- History of gas company innovation—Nick Pezner, University of Pennsylvania
- Induction cooking—Scott Blunk, SMUD

Short polls asked:

- What do you believe is the biggest concern participants will have about networked geothermal? These responses generated a wide range of worries, misconceptions, and observations about human nature.
- What is the most compelling aspect of the GeoMicroDistrict? This knowledgeable stakeholder audience had dozens of reasons for supporting GeoMicroDistricts, covering a range of values and players.

Conducting these polls served as a warmup exercise to begin gathering concerns and motivators for upcoming demonstration programs. Stakeholders could see one another’s responses, sparking more ideas. They were then allocated to eight teams, two focused in each of the following areas:

- Municipal concerns, especially for the Department of Public Works
- Stores, businesses, and large building owners
- Residents, both renters and owners
- Multiunit building owners of both low-income and market rate units

An additional ninth team was assigned to organize, edit, and expand a frequently asked questions document.

The task was to develop a handout, and a sample was available, however some of the teams noted that other channels would be more effective. Each team was also asked to analyze and record benefits, concerns, and questions relevant to their stakeholder group.

The draft handout focused on defining a GeoMicroDistrict and listing the categories of benefits. In general, groups started out by trying to edit this document, then gradually moving away from it as the concerns or market barriers of their participant group became clearer, along with ways to meet those concerns.

By the end of the exercise, the groups had come to realize that building owners want to know about asset value, renters want to know what will happen to their rent, small business owners want customers, and municipalities want happy citizens who will re-elect incumbent politicians. Stakeholders were able to ferret out and understand which benefits will appeal to each of these audience segments. Several groups also came to the conclusion that a handout is the wrong medium for their audience. Instead, they suggested a neighborhood barbecue or working through a team composed of utility and community representatives. The handouts below exhibit the best ideas from each pair of groups.

## Report

The 79 participants in this Charrette worked in nine breakout groups: two groups focused on municipalities, two on residents both renters and owners, two on small businesses, and two on large building owners. A final group was tasked with drafting frequently asked questions.

The task for the audience segment groups was to design a handout. This appendix summarizes the output by combining the work of the two groups focused in a particular area. Duplicate points are only listed once.

### Municipalities: Benefits, Concerns, and Questions

The following combines input from the two discussion groups.

#### *Benefits*

A tool for communities to help meet their emission reductions and climate goals

Offers both a heating and cooling solution

Improved resiliency

Construction could be leveraged with other infrastructure changes

Deploying high performance districts

Foundation for integration of thermal and power grids

Energy savings

Cost-effectiveness

Safety First!

Public resentment and fear of natural gas explosions

Healthier indoor air

#### *Concerns*

Need to sell it to select board and town meeting over several years

Push back from industry and economic development groups



Re-election—public officials will look bad if it doesn't go well, so have to deploy successfully

Voluntary participation, not a mandate

Equity in a neighborhood

Could the pricing structure change in a negative way? Especially for EJ communities

What about people who don't want to switch? Leaning towards "rights" issues

Share data from pilots; don't want to be the first to implement a new technology

If there's a problem, what will be impacted? What other utilities are doing this?

Drilling and other site work in or near wetlands or contaminated sites could be a problem.

Interactions with other infrastructure underground

Is this a permanent change or will we need to switch back?

Will we be locked into converting the whole town?

What happens if it doesn't go well—what's the backup plan?

### *Questions*

More information is needed about pilot preparation as well as operations.

What brand and quality of ground source heat pump will be used?

Has this been done successfully before?

Can I talk with someone or a group that's been through this transition?

What is the chance this will be obsolete anytime soon?

What are competing technologies contemplated that do similar things?

When do decisions need to be made?

When is the disruption going to happen?

What are the environmental impacts of GeoMicroDistricts?

What happens after the pilot? What are the ongoing costs to participants?

Will this impact operating costs for the municipality?

Will we need special skills to maintain this system?

Are there local contractors to service and maintain the systems?

How long will the disruption last?

Can buildings and customers switch back at the end of the pilot?

Can customers back out at any time—say, before the end of the pilot?



## Stores and Businesses: Benefits, Concerns, and Questions

The following combines input from the two discussion groups.

### *Benefits*

Benefits for business and building owners were segregated by business interests and property value.

#### General Benefits

- Lower costs and cost stability
- Social awareness of business carbon footprint
- Climate change accountability; reduced GHG emissions
- Improved air quality
- Improved indoor comfort for customers
- Future proofing the business at zero cost

#### Small mom and pop grocery store, defined as a 5 to 10-year commercial lease

- Cost savings and lower cost on common area meter charges
- Lower maintenance costs
- Advertise as green business
- Possibility of air conditioning
- improved quality of service
- Improved resiliency and reliability
- Safety, get rid of gas in my building

#### Property owners

- Increases asset value
- Advertise as green building for higher rents
- Capital cost is zero for advanced, efficient system
- Increases safety by getting rid of gas in building

#### Warehouse space

- Primary concern is steady temperature
- Achieve through a combined heating and cooling system
- Capital cost is zero for an advanced efficient system
- Low operating costs

#### Commercial office space, lessees

- Lower, more predictable cost
- Comfort ranges are improved, fewer tenant complaints

#### Restaurants and Kitchens

- Lower, predictable cost
- Comfort range improved
- Safety from getting rid of pressurized gas
- Cleaner air quality
- Outdoor dining—instead of propane heaters, radiant flooring



## Concerns

### General Concerns

Gas dependent businesses, such as pizza parlors  
System failure during business hours  
Lack of education or awareness that system will work  
Blind confusion about how water could possibly work?  
How can not combusting something provide heating?  
Materials—where can people learn more?  
What if system does not maintain comfortable temperatures?  
What are the retrofit issues with distribution system equipment?

### Small mom and pop grocery store, defined as a 5-10 year commercial lease

Reliability of the system  
Customer access to the store during construction  
What happens to my lease—does my rent go up?  
Who has done this, show me how it's worked.  
Does it meet local building code?

### Property owners

What does this do to my asset?  
What does drilling all the holes in the ground do to my foundation?  
Could geothermal be a problem if the water table is high?  
What is the quality and speed of service if something goes wrong?  
Help with tenant relations.

### Warehouse space

Traffic disruption—have trucks coming in and out, and time is money  
Business disruption—who's responsible for the cost if I lose money?  
Winter storm, other loss of electricity

### Commercial office space, lessees

How long will drilling take on the street—business disruption  
Temperature limits—what are the comfort ranges

### Restaurants and Kitchens

Don't mess with my GAS STOVE!!  
Customer disruption and access during construction. Will it be dirty?  
NOISE

## Questions

### General Questions

What if it doesn't work as expected, and I gave up my old equipment?



How long is the change out—will it be seamless?  
How will parking and traffic disruption be handled?  
Will bills go up over time to cover installation and operational costs?  
What is the availability of technicians and technical back up?  
What is the guarantee of energy savings?  
Shouldn't we keep the gas system for redundancy during extreme weather events?  
What are you asking me for, you will do it anyway.

### Small grocery store, mom and pop

Are there examples nearby?  
How much maintenance do I have to do?  
Will there be insurance savings or does my insurance go up?

### Property owners

Who is trained and who do I call to take care of me when something goes wrong  
How long is it going to take to fix it, are parts available?

### Warehouse space

What happens to the heat in the winter if electric power goes down?

### Office Space

What are comfort ranges?  
Can Eversource be proactive and meet with tenants, take the heat off the owner?

### Restaurants and Kitchens

Some electric stoves are too expensive to switch  
Do you have a high quality and reasonable cost replacement?

## Homeowners and Renters: Benefits, Concerns, Questions

The following combines input from the two discussion groups.

### *Benefits*

- Upfront costs covered
- All energy charges included for both electricity and gas
- Fixed low energy bills
- Low equipment maintenance
- 50% savings over oil
- No lien on property for sales
  
- System is more reliable
- Cooling as well as heating
- Trust in utilities
- Higher efficiency of ASHP due to lower temperature difference
- Space savings by removing radiators
  
- No carbon monoxide
- No fossil fuel



Safer, not explosive  
Lower emissions

Better indoor air quality  
Becomes a green building  
Healthier

### *Concerns*

Are weatherization and upgrade costs included?  
Unfamiliar technology  
Street torn up, parking  
Distrust of utilities: badly treated; broken faith  
Rents go up as building value increases  
Effect on associated jobs: weatherizers; window installers; energy efficiency  
Due to a lower cost of energy, people will not be as interested in weatherizing  
Will it be reliable on cold days?  
Will this system really work in my home?  
Can the grid handle electric demand of total electrification  
Leave gas in place for redundancy instead of a total switch from old system

### *Questions*

Do you upgrade weatherization?  
Do utilities pay for induction cooktops, fireplace inserts, hot water heaters?  
Would insurance go down for properties with geothermal with no explosion possibility?  
What is the cost amortized over decades?  
What is the transition like with disruption, trenching?

## Multunit Building Owners: Benefits, Concerns, Questions

The following combines input from the two discussion groups.

### *Benefits*

Insulated buildings  
Fuel cost diminishes  
Safer and cleaner air  
Comfort of tenants  
Building is safer  
Carbon reduction  
Turnkey delivery of system, managed by utilities  
People around the world are doing this  
More attractive long-term to renters  
This will happen anyway in 20 years, so being first, receiving a service

### *Concerns*

Communications with unit dwellers  
Owner-occupants might not have an incentive to participate  
Long-term costs could go up  
Utilities may convert back to gas  
Upfront costs for owners  
Reliability of new technology  
How long is construction and how disruptive for renters  
How maintenance is handled





How renter complaints are handled

### *Questions*

How do utilities put together the capital costs?

What are the operating costs over the next 5 to 10 years?

Do the utilities convert the system back to gas once the pilot is over, if they choose not to support it?

Will gas boiler backup be necessary or used?

Do the Merrimack Valley building owners need an incentive to get people to move into the building?

Do you let participants "phase in"? So that we can align timelines better?

Is there a reason to eliminate gas entirely?

Can you have two to three holdouts in a building who use gas instead of converting?

Can the state provide incentives to building owners who agree not to raise the rent?

How disruptive will construction be?

Will people have continuous access to the building?

Will the building be heated and cooled continuously during construction?

Can HEET work with a building owner who wants to do retrofits?

How will the utility be aware of and responsible for the community engagement process?

Can each audience be addressed through a different approach?

Can we put together testimonials from around the world about conversions?

Can utility message that gas won't be an option in 20 years, and they are offering an option?

Will utilities target different types of multi-unit owners—condo associations, low income?

## Appendix A Sample Handouts

On the following pages you will find the handouts for each audience segment.



## Municipalities, Department of Public Works

Here in Townville, we're proud of our track record leading on climate action while supporting the well-being of our residents and our vibrant business community.

We're excited to offer a better way to heat and cool our buildings, with safer indoor air quality, lower energy bills, and reduced emissions. And it provides great green jobs for our hard-working utility crews in the process.

This is networked geothermal heating and cooling, and it's coming soon to Townville!

This system, called a GeoMicroDistrict,<sup>cc</sup> uses existing, commercially available and proven technology and equipment, interconnected in a new design in the gas right-of-way under our streets. As one of the first towns using this design, we are starting with a five-year trial in the Townville neighborhood.

Participating buildings pull the heating and cooling they need off the system using heat pumps. The pipes in the street are filled with water and managed by the utility. Bills will be lower, and that's especially important for our lower and middle income families who spend a large portion of their income on home energy costs. It also means greater reliability and resilience for essential heating and cooling, which our residents and businesses rely on.

The timing is right for this trial, because the installation of new thermal loops, drilling shallow boreholes and laying new pipe under the street, lines up with our multi-year sewer separation project in the Townville neighborhood. While the streets are opened up, we're building back better.

We're honored that GasCorp has asked Townville to participate in this trial. We look for many other towns around our state to build on its success, and together achieve our state's essential climate goals.

How does the trial work?

- We'll hold a series of open information sessions and town hall forums for all residents and business leaders. The first one is coming up on DATE TIME
- Our DPW team gets to work closely with, share expertise, and learn from GasCorp and all the other collaborators. We are making history together.
- For all customers, participation in the pilot is voluntary. Participants can also change their mind and return to prior heating and cooling services at any time. GasCorp installs and maintains all new equipment, including heat pumps and associated gear in the buildings, at no expense to customers

At the end of the trial, we'll review the results and decide whether to keep expanding the GeoGrid or go a different route.



## Stores and Businesses

**Come to the J Square Neighborhood Barbecue!**  
**May 9th. Festivities start at 4:30 PM**

Bring your kids, dogs, a blanket to sit on, and, if you like, a favorite dish to share. We'll have burgers—meat or not—with all the fixings, sides, drinks, and dessert.

Enjoy some great food and hear about an opportunity to modernize your heating and cooling system at no upfront cost to you.

Sound too good to be true? Councilor LaWanda Johnson will be there with Edgar Heet to tell you what's going on. The utility is planning to meet state environmental goals, and has picked our neighborhood to be the first to benefit.

- We're offering a new way to heat and cool that is better than what you have now
- We're designating this a Green Business District to appeal to your customers
- There's no upfront cost to you for either the new system in the street or the new equipment in your building
- You'll pay \$x per month in fixed energy costs

### Timeline

- Construction in the street starts in June 2021 and lasts for approximately six months.
- Disruption will be managed so employees and customers feel safe and can get where they need to go.
- Our primary concern is your comfort inside your building.

Utility will have a liaison available to work with you on any issues or concerns that arise. Utility is committed to making this new business model work, and wants to learn from your experience.

Ready to reduce your bottom line and increase your profit?

Join Utility's new system for heating and cooling your business.



# Homeowners and Renters

## Join the Networked Geothermal System on your Street

### Safer, Better Indoor Air, Lower Energy Bills, and Emissions

Your utility is offering you a modern heating and cooling system along with building improvements at no cost to you. You'll pay one monthly bill that is lower than what you were paying for both electricity and either gas or oil.

The utilities are planning to meet the state's goals for a cleaner environment. Making sure your home or apartment is safe, has good indoor air quality, and doesn't waste energy is an important step.

As a participant, we'll keep you informed with weekly newsletters and community meetings. You can also call or email your community liaison with any questions or concerns that arise. By participating in this demonstration project, your home or apartment will be more comfortable, more modern, and cleaner.

#### Energy bills

- You'll pay either the low income rate of \$x/month or the residential rate of \$y/month during the duration of the demonstration.
- You'll get new heating and cooling equipment for free.
- If you own your home, maintenance charges will be lower with new equipment.

#### Timeline

- Construction in the street right-of-way is expected to start in June 2021 and last through October.
- We are developing a traffic management plan and welcome your input.
- Retrofitting your home will take one to two weeks, depending on how much work is needed to upgrade your heating system.
- The utility will schedule building retrofits when it is most convenient for you.
- You won't have to leave the premises as long as you provide access to the rooms where new weatherization or ductwork may be needed.

For more information visit [www.mynetgeo.com](http://www.mynetgeo.com).

Or contact your local community sponsors:

M. Smith, Neighborhood coordinator ([MSmith@netgeo.com](mailto:MSmith@netgeo.com))

Y. Jones, Utility contact ([YJones@netgeo.com](mailto:YJones@netgeo.com))

This document is available in multiple languages. Check the website to download your preferred language or contact your community sponsor.

# Multi Unit Building Owners

## Join the Networked Geothermal System on your Street

Safer, Better Indoor Air, Lower Energy Bills and Emissions

To meet the state's 2050 emission goals, utilities are phasing out gas. Instead, utilities are offering a more environmentally friendly way to heat and cool your building. Buildings take the heating and cooling they need off the new system using heat pumps.

When you participate in a five-year pilot study, Eversource or National Grid pays to convert your building to the new system. There's no upfront cost to you or your tenants for this conversion.

If you join the program now, your building's heating and cooling costs will be a low fixed cost during the five years of the study. Longer term your building's utility costs are also expected to be lower.

This system is safer than gas and results in better indoor air quality. Joining the program makes your rental property more attractive by having comfortable, efficient, and quiet heating and cooling. Tenants benefit from new, modern cooking appliances.

### Energy bills

- Individually metered units will pay either the low income rate of \$x/month or the residential rate of \$y/month during the duration of the demonstration.
- Common area charges will be set for \$z/month.

### Tenant relations

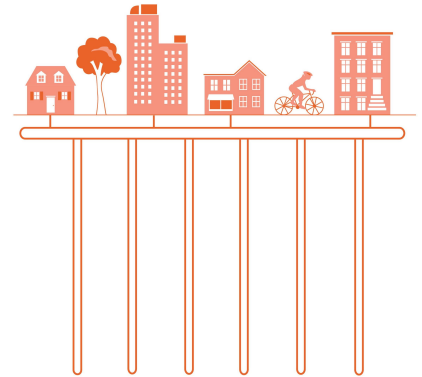
- We will meet with your tenants on a regular basis and send you weekly progress reports to help with your tenant communications.
- We will also work closely with you on traffic management.

### Timeline

- Construction in the street right-of-way is expected to start in June 2021 and last through October.
- The utility will schedule building retrofits during that time period when it is most convenient for you.
- Retrofitting each unit in your multi-family will take one to two weeks, depending on how much work is needed to upgrade the heating system.
- Renters will not have to leave the premises as long as they provide access to the rooms where weatherization or ductwork may be needed.

### What happens after the five-year demonstration?

- You'll have new heating and cooling equipment for free.
- Modernizing your units makes them safer and more appealing to tenants.





For more information visit [www.mynetgeo.com](http://www.mynetgeo.com)

Or contact your local community sponsors:

M. Smith, Neighborhood coordinator ([MSmith@netgeo.com](mailto:MSmith@netgeo.com))

Y. Jones, Utility contact ([YJones@netgeo.com](mailto:YJones@netgeo.com))

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# Appendix B: Frequently Asked Questions

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## Networked Geothermal FAQs

### Benefits compared to natural gas

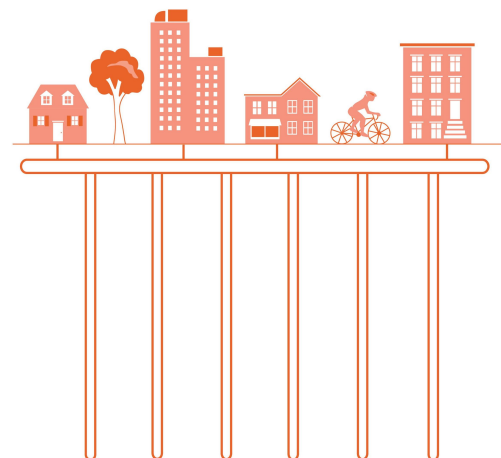
- Safer
  - Lower energy bills
  - Lower emissions
  - Less (shared) installation cost
  - Can provide cooling
  - Quieter
  - More reliable
  - Improved indoor air quality
- 

## Networked Geothermal

### What is a heat pump?

Your freezer is a heat pump. It pumps heat out of the space to keep the ice cold. Even when your kitchen is 90 degrees, your freezer works effectively.

Heat pumps work the same way, except heat pumps can pump heat into or out of a building. They can keep your home warm in the winter and cool in the summer.



### How do ground source heat pumps work?

As water is moved through pipes under the ground, it becomes the same temperature as the earth, around 55° F. During heating season, your heat pump moves heat out of the water into your home. During the cooling season, the heat moves heat from your home into the water.

### Why use ground source heat pumps?

Unlike the temperature of the air, which varies with the weather, the ground is always a consistent temperature, around 55° F. Not only is this close to the temperature you want in the house, it's a temperature that keeps heat pump appliances in your home happy, allowing them to work with the greatest efficiency.

### Why not just use an air source heat pump?

Air source heat pumps work well and are very efficient most of the time. They use 1 unit of energy to move 2 to 3 units of energy into or out of your building, making them far more efficient than electric resistance heating, air conditioners, or gas furnaces. However, they struggle on the coldest and hottest days, and it can be expensive to purchase and operate them. Adding in the support of a GeoMicroDistrict makes the heat pump convert one unit of energy to 3 to 5 units of output, so it becomes much more efficient and more affordable.

### Why network the heat pumps?

By connecting buildings together through a network of ambient-temperature water, buildings can move heating and cooling between them. For example, the neighborhood supermarket can pull cold off the system for its fridges, making the water hotter for nearby homes. Any extra energy not needed at the time can be stored in the ground or shared with a nearby GeoMicroDistrict.

### Are the emissions lower?

Yes. The only energy used would be electricity to run the water pumps and fans. Given how our electricity is generated in Massachusetts, the emissions will be 60% lower than gas immediately and these emissions will reduce more as our electric grid uses more renewables.

### Did I hear you say GeoMicroDistricts store heating and cooling?

The network can store either heating or cooling in the ground to be used later. The only rule is that over time, you have to withdraw as much temperature as you put in, so you maintain the temperature of the ground in the range that keeps the heat pumps happy.

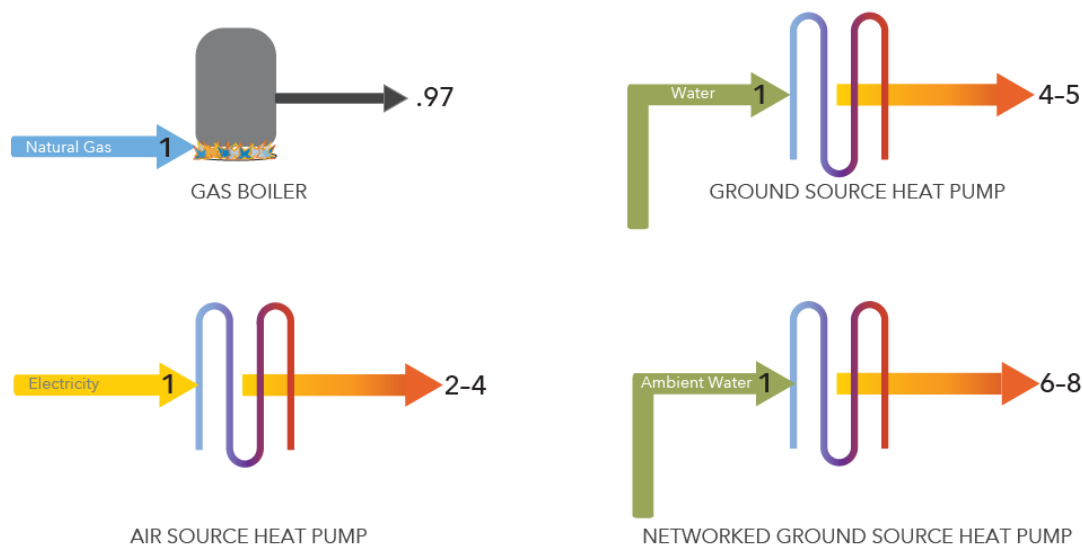
## Why switch from natural gas?

### Is networked geothermal safer than gas?

Yes. Networked geothermal systems contain just water, so there's no potential of an explosion, as there is with gas. If one of the pipes leaks, it just waters the nearby trees.

### Is it more efficient?

Yes. Heat pumps *move* naturally occurring heat rather than create it through burning something. They are thus much more efficient.



*Comparison of efficiency for four different HVAC technologies. Upper left: a gas boiler delivers .97 units of energy for every unit put in. Lower left: An air source heat pump on its own delivers two to four times the energy input. Upper right: A ground source heat pump connected to a building's air source heat pump ups efficiency to four to five units of energy for every unit input. Lower right: Most efficient of all is a ground source heat pump, sharing energy with other buildings and connected to an air source heat pump. It can deliver as much as 8 units of energy for every unit expended.*





### Do you still need electricity?

Yes. The water pump in the street and the heat pump in your home use electricity. This electricity emits less than gas and, in Massachusetts, the electric grid will be net zero by 2050. This means that every year your home will reduce its emissions without you doing anything.

### Will my energy bills be lower?

Yes, because all you're paying for is the system—there are no additional fuel costs other than a small amount of electricity. Because it's so efficient, your energy bills will be lower than they are with natural gas.

### How reliable is the system?

More reliable than gas. The gas system is like a tree, with the gas moving only in one direction, from the trunk to the ends of the branches. This means if any feeder branch fails, you lose gas. With interconnected GeoMicroDistricts, if any one fails, the others can function independently.

### Are there systems like this working now?

Yes, one example is installed at the Colorado Mesa University in Grand Junction, Colorado. It's been running well for over a decade. You can see a list of other projects on [page 56 of the Buro Happold GeoMicroDistrict Feasibility Report](#).

### How does it affect air quality?

Burning fuels such as gas, propane, or oil in the home puts pollutants into our indoor air. These pollutants are correlated with increased rates of asthma in children and other respiratory diseases. With networked geothermal, there's no combustion in your home, making the air you breathe cleaner.

### Can it work for supermarkets, labs, hospitals, and ice rinks?

Yes. The system can provide the heating and cooling needed. In fact the more different types of heating and cooling added to the system, the more efficiently the system functions.

### What temperature is the water in the system?

The water temperature is kept between approximately 40 and 90 degrees Fahrenheit. Keeping it in this range helps keep the heat pumps in the homes happy and efficient.

### Why is low temperature water better than steam or hot water?

Low temperature water loses less energy to the surrounding ground, making it more efficient. Also, it can deliver cooling, which we will need more of as our climate warms.

### What if the water gets too cold?

There is a backup gas heater on the shared loop to heat the water up if needed. In a system installed at Colorado Mesa University, the gas backup heater has not been needed for supplemental heat for over a decade.

## Anything else you want to know?

### Are these deep boreholes?

We are not talking deep geothermal, but boreholes that are just a few hundred feet deep.

### Can boreholes cause earthquakes?



No. The holes themselves are only a few inches wide. Narrow and relatively shallow boreholes are not known to cause earthquakes. .

#### Does the system use a lot of water?

No, it is a closed system which only has to be filled once. The same water is just pumped up and down the street, delivering heating or cooling to the buildings.

#### What happens if it leaks?

Leaking is very rare. If the system does leak, it just waters nearby trees. The leaks can be fixed and the system refilled.

#### Will it damage the water table?

No, it is a closed system. Leaking is very rare. If it does leak, it is just plain water.

#### Why have gas utilities run them?

Installed by utilities, the cost of the system is shared across all customers over decades, allowing everyone to access the system. Also, unlike private companies, utilities are tightly regulated to ensure they are delivering a good product for a reasonable cost.

#### What are the upfront capital costs?

Installing a large project requires capital; utilities have a long history of raising and investing capital, then earning a return on that investment through ratepayer revenue and other fees and income. It is a high upfront investment, but utilities are constantly making these investments. Witness the Gas Safety Enhancement Program at a billion dollars a year, or the electric side investment in utility-scale solar. Utilities must show that their investments are cost-effective, that all customers are served, and that they are spreading the investment cost fairly and over a long period of time.

#### What are the operating and maintenance costs?

Because water is a liquid, it's less likely to leak and need repairs than either fracked gas or hydrogen gas. Operating costs will revolve around the personnel and equipment needed to balance the underground temperature and energy transfer among buildings.

#### What happens when the system breaks down?

Depending on the kind of breakdown, several things can happen. If the break is inside your GeoMicroDistrict, trained technicians can bypass the break while they fix it. If the break is in a neighboring GeoMicroDistrict, your GeoMicroDistrict may be sharing more energy than normal with the neighborhood. If the electric power goes down, your GeoMicroDistrict won't be pumping water while there is no power, however, because water maintains a steady temperature better than air, you may not notice it.

#### What are competing technologies contemplated that do similar things?

There are other forms of geothermal technologies, but none that substitute for the gas utility function as well as the GeoMicroDistrict. Some gas companies are considering piping hydrogen into people's homes, initially as a mix with fracked gas, but this is not a long-term solution that achieves our carbon goals.

#### After the demonstration project, will the utilities convert buildings back to gas?

Eversource will switch you back to gas if you want. National Grid won't because they don't want to replace the pipeline they've installed.